Lesson Title	Chemical Bonding
Length of Lesson	90 minutes
Created By	David Wilson
Subject	Chemistry / Eighth Grade Science
Grade Level	9-12th Grade
State Standards	2a, 3b / 1b, 1d
DOK Level	1, 1 / 3, 3
DOK Application	Describe and Classify / Distinguish, Analyze
National Standards	K-12: Unifying Concepts and Processes / 5-8: A: Science as Inquiry, B: Physical Science / 9-12: A: Science as Inquiry, B: Physical Science
Graduate Research Element	An understanding of the nature of chemical bonds is fundamental to research in chemistry.

Student Learning Goal:

State Standards: (Chemistry)

2) Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

a. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK1)

e. Compare the properties of compounds according to their type of bonding. (DOK1)

State Standards: (Eighth Grade Science)

1) Draw conclusions from scientific investigations including controlled experiments.

b. Distinguish between qualitative and quantitative observations, and make inferences based on observations. (DOK3)

d. Analyze evidence that is used to form explanations and draw conclusions. (DOK3)

National Science Standards: (K-12)

Unifying Concepts and Processes:

As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes:

- **Systems, order, and organization**
- **Evidence, models, and explanation**
- Constancy, change, and measurement
- Evolution and equilibrium
- Form and function

National Science Standards: (5-8)

A: Science as Inquiry: Abilities necessary to do scientific inquiry:

- DEVELOP DESCRIPTIONS, EXPLANATIONS, PREDICTIONS, AND MODELS USING EVIDENCE. Students should base their explanation on what they observed, and as they develop cognitive skills, they should be able to differentiate explanation from description—providing causes for effects and establishing relationships based on evidence and logical argument. This standard requires a subject matter knowledge base so the students can effectively conduct investigations, because developing explanations establishes connections between the content of science and the contexts within which students develop new knowledge.
- THINK CRITICALLY AND LOGICALLY TO MAKE THE RELATIONSHIPS BETWEEN EVIDENCE AND EXPLANATIONS. Thinking critically about evidence includes deciding what evidence should be used and accounting for anomalous data. Specifically, students should be able to review data from a simple experiment, summarize the data, and form a logical argument about the cause-and-effect relationships in the experiment.

B: Physical Science: Properties and Changes of Properties of Matter.

- A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample. A mixture of substances often can be separated into the original substances using one or more of the characteristic properties.

National Science Standards: (9-12)

A: Science as Inquiry: Abilities necessary to do scientific inquiry.

- FORMULATE AND REVISE SCIENTIFIC EXPLANATIONS AND MODELS USING LOGIC AND EVIDENCE. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical. In the process of answering the questions, the students should engage in discussions and arguments that result in the revision of their explanations. These discussions should be based on scientific knowledge, the use of logic, and evidence from their investigation.

B: Physical Science: Structure and properties of matter.

- Bonds between atoms are created when electrons are paired up by being transferred or shared. A substance composed of a single kind of atom is called an element. The atoms may be bonded together into molecules or crystalline solids. A compound is formed when two or more kinds of atoms bind together chemically.

Materials Needed (supplies, hand-outs, resources):

{**WARNING**: Please read the MSDS of any chemical before using it.}

[Chemicals needed]
$LiCl_2$, $CaCl_2$, aspirin (powdered), $NaNO_3$, *p*-dichlorobenzene, sucrose, distilled (deionized) water
[Quantities of the following supplies listed are per each group.]
ring stand, iron ring, conductivity apparatus, disposable plastic pipets, small pie pan, Bunsen burner, spatula, well plate, 6 test tubes

Lesson Performance Task/Assessment:

1) Students will investigate three properties of six compounds.
2) Students will categorize each compound into its class of compound (ionic or covalent) based on the bonding of those compounds.
3) Students will make use of three experimental skills by determining the solubility, melting point, and conductivity of the compounds.

Lesson Relevance to Performance Task and Students:
The students are beginning to learn about the different types of chemical bonding. This lab will cause them to begin to rationalize and explain why the different types of chemical bonding impart different, easily observable properties upon compounds. The students will continue to extrapolate atomic behavior from the macroscopic properties of matter.

Anticipatory Set/Capture Interest:
Two demonstrations. First, the supersaturation of sodium acetate and the supersaturation of sugar will highlight the different properties of ionic and covalent (and Van der Waals) which cause crystals of ionic and covalent compounds. Second, the production of zinc sulfide versus sulfur dioxide will show the stability innate in ionic compounds compared to covalent compounds.

Guided Practice:
At this point, the students will have gone over the properties of ionic and covalent compounds in class, and they will have had practice distinguishing between the different types. This lab is meant to give them independent, practical practice in applying what they have learned.

Independent Practice:
The purpose of this lab is to give the students experience in applying the principles they will have learned up to this point. So, the entire lab is an exercise in independent practice.

Remediation and/or Enrichment:
Remediation: Individual IEP.
Enrichment: (I can't think of anything for this. I'm not good at this part.)

Check(s) for Understanding:
Post-lab questions and the data tested will be used to evaluate student understanding. See the attached lab handouts.

Closure:
Since the lab will occupy the entire period, the teacher will review the post-lab questions with the students when they turn them in the following day, and the teacher will questions the students about what they learned from the lab.

Possible Alternate Subject Integrations:
This lesson is purely physical science.

Teacher Notes:
Demonstrations can be found on Youtube: 1) Supersaturation of sodium acetate - http://youtu.be/nvHrXr5Jajg and Supersaturation of sucrose - http://youtu.be/4uXQ2Uoaa_M . 2) Synthesis of zinc sulfide - http://youtu.be/7XDF_qw4ohI and Synthesis of sulfur dioxide - http://youtu.be/V1sQO91UvFI .